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Inventor: THIRIOT LAURENT (FR)
Applicant: KERMEL (FR);; THIRIOT LAURENT (FR)
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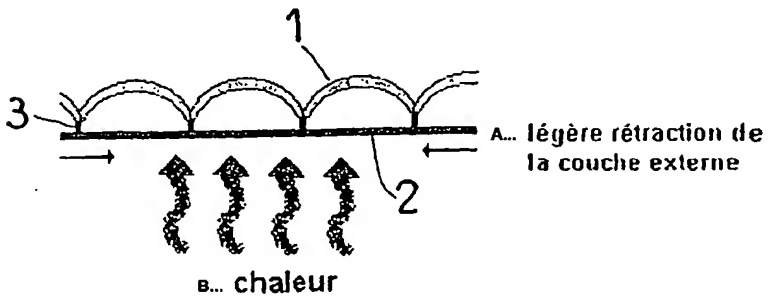
(54) Title: SHEET OF COMPLEX, MULTI-LAYER MATERIAL WHICH CAN BE USED TO PRODUCE PROTECTIVE CLOTHING, PARTICULARLY FOR FIRE FIGHTERS



A... LÉGÈRE...EXTERNE: SLIGHT SHRINKING OF THE OUTER LAYER
B... CHALEUR: HEAT

(57) Abstract: The invention relates to a sheet of complex, multi-layer material which can be used to produce protective clothing, particularly for fire fighters. The inventive material is characterised in that it is produced by means of weaving or knitting. In this way, a structure is created having two stacked faces (1, 2) which are intermittently interconnected in such a way as to form pockets. According to the invention, one of the aforementioned layers shrinks under the effect of heat and the link between said layers is provided by the intermittent binding of a selection of threads in order to form the pockets.

COMPLEX MULTI-LAYER MATERIAL IN SHEET USABLE FOR THE REALIZATION OF PROTECTIVE CLOTHING, IN PARTICULAR FOR FIREMEN.

Technical field

The present invention relates to fabrics, in sheet form, intended to carry out protective clothing, in particular working jackets of people intended to be subjected to extreme conditions, in particular in the case of fire.

It relates in particular with a new type of material usable to carry out clothing of firemen, without for that excluding other applications.

Former techniques

In the continuation of description, the invention will be described for a particular application, namely making of working jackets of firemen.

It is obvious that that is not restrictive and that such a material could be used for other applications, and in all the cases where one is in the presence of extreme conditions, for example at the time of a fire.

To date, to carry out working jackets, one uses multi-layer structures which, generally, as that arises from annexed figure 1, are composed in general of four elements, namely: an external fabric (A); a waterproof and breathing membrane, in general associated a substrate (B); a thermal barrier generally made up by a needled felt (C); and a finishing lining (D).

The realization of such complex materials usable under extreme conditions, is perfectly known by an expert and arises in particular from the French patent 1.213.415.

Since, such structures evolved by calling in particular upon textile materials resisting heat and fire, containing aromatic polyamide or polyamide imide.

Among these the most known synthetic matters, one can quote, in the family of aromatic polyamides, the thread or fibers para-aramides, as marketed by DuPont de Nemours under the name *"KEVLAR"* or by company TEIJIN under marks "*TWARON"* and "*TECHNORA*". Such polymers, which can thus be appeared as fibers, thread, or other structures, were the subject of many publications among which one can quote the US patent 3.063.966.

Among the materials also resisting heat, and which belong to the family of meta-aramides, one can quote polymer marketed by Company KERMEL under the same name, the fibers marketed under mark "*NOMEX"* by the DUPONT de NEMOURS and those marketed under mark "*CONEX"* by company TEIJIN.
As indicated previously, the invention thus relates to the sector of the realization of multi-layer materials as illustrated in figure 1.

In these materials, a problem arises with regard to the thermal barrier, generally consisted a needled felt, and the finishing lining located on the side of the user.
Indeed, the complexes suggested to date have a disadvantage which lies primarily in the fact that clothing carried out misses comfort as well on the physical level as on the physiological level.

Moreover, under certain conditions, they miss effectiveness.

Indeed, it was reported that approximately 50% of the causes of death for the firemen intervening to the United States, are the consequence of a phenomenon manifestly known in the field by the term *"heat stress"*, which is a state in which the body cannot maintain any more one temperature in lower part of 39°C, which involves various disorders being able to be, in addition to a physical loss of capacity, a loss of clearness, a fainting or a heart failure.

Such a state of stress is caused, in particular by the weight of the equipment which can exceed 20 kilograms, like to the capacity sometimes too insulating their protective clothing.

Disclosed Invention

However one found, and it is what is the subject of this invention, that it was possible to solve this problem by the realization of a new type of material making it possible to provide a thermal function of barrier and preferably also of finishing lining of the former complex structures of the type of those illustrated on figure 1

This new type of complex, which one will name by the expression "thermal barrier", allows an insulation moderated in normal situation by the fact that it presents a low thickness and a small thermal load, which thus improves of it the comfort and which, according to the increase in temperature, makes it possible to have an increase in the insulation, this increase being able to be localized at the area where heat is most important when the user is confronted with an emergency vis-à-vis fire.

Generally, such a possibility is obtained in accordance with material according to the invention, by carrying out a complex fulfilling the functions at the same time of thermal barrier and finishing lining, by calling upon a technique of realization of woven fabrics, technique known under the name weaving of fabrics "pocket" or bonded double fabric.

Such technology consists to realize into only one operation, two fabrics (or more), distinct and superimposed, which is connected between them by a thread selection (warp or weft]) which binds alternatively, according to a predetermined selection, with one or the other of the weaves of two superimposed fabrics.

As an indication, a warp thread of the top face can, according to a predetermined sequence, be linked with a warp yarn of the lower face. This link can be made according to any type of reason, classically to form rhombuses or many tubes.

Generally, depending on the state of the art, one reverses the faces towards and place of color different to obtain a decorative effect, which is not desirable within the framework of the invention where each face must have a particular function.

Possibly, such double face structures can be also carried out by knitting, either according to the sunk loop technique or according to the reinforcing loop technique, more particularly on a Raschel or warp type knitting machine.

Generally and taking into account the problem arising to produce a thermal barrier in the case of a protection in particular for clothing of firemen while having for objective to improve comfort of the aforesaid clothing, as well on the physical level as physiological, it was conceived according to the invention a multi-layer complex material in sheets making it possible to produce a thermal barrier made up of a first and of a second layer, characterized in that the material is carried out by weaving or knitting, so as to form a double face superimposed structure (1, 2), connected intermittently between them so as to form pockets, and in which:

one of the layer shrinks under the effect of heat;

the connection between the layers is carried out by intermittent binding of a thread selection to form the aforementioned pockets.

Advantageously, the layer presenting a shrinking under the effect of heat is made up, entirely or partly, of thread presenting a shrinking under the aforementioned effect of heat.

According to a preferred embodiment, the pockets constitute channels, only the family of thread perpendicular to the known as channels, considered entirely or partly, presenting a shrinking under the effect of heat.
Without leaving the framework of the invention, the effect of shrinking of the barrier layer considered of thermal can result from the presence of a membrane fixed on the aforementioned layer, or of a coating.

Description of the drawings

The invention and the advantages which it brings will be understood however *better* thanks to the description which follows of an example of complex in conformity with the invention and which is illustrated by the diagrams annexed in which:

Figure 1 illustrates, as indicated previously, a conventional complex multi-layer used to date for the realization of clothing of personnel of intervention under conditions of risks, in particular of clothing of firemen;

Figure 2 is a diagrammatic view in prospect showing an example for structure of a complex making it possible simultaneously to produce the thermal barrier and the finishing lining present in the above mentioned complexes;

Figure 3 is a diagrammatic view cut out of a material in conformity with the invention when the user is under normal working conditions;

The figures 4 and 5 illustrate, seen cut out and prospect, in a diagrammatic way, the change of the complex in conformity with the invention when the user is confronted with a sudden change of the operating conditions, and more particularly to a sudden increase in heat;

Figure 6 illustrates, in a conventional way, on the one hand, as that arises from the view of left, a double faced fabric in conformity with the invention, and on the other hand, as that arises from the view of right-hand side, the fabric obtained on the front face (face lining);

Figure 7 is a conventional representation showing, seen cuts direction from there chains, the work of the thread sheets of chain compared to weft threads, in order to constitute a double faced fabric of the pocket type, bound between them according to a predetermined sequence.

By referring to the annexed figures 2 and 3, the basic structure in conformity with the invention is thus consisted a fabric pocket including an internal layer indicated by the general reference (1) an external layer indicated by the general reference (2), these two coupled layers being one with the other and being dependant between them, intermittently, by a thread selection of chain (3), thread selected among those constituting the internal layer.

In other words, in such a structure, the flowlines (3) form, between them, of the flat pockets made up between the internal layer (1) and the external layer (2).

In our example, as that arises more particularly from figure 2, the thread of chain (C1) intended to form the inner layer (1) side lining, as well as weft threads (Tl), consist of thread and more particularly of threads of fibers practically not presenting any capacity to shrink under the effect of an intense heat.

The thread of chain (C2) intended to constitute the external layer (2), are made up as for them thread presenting a light capacity of shrinking compared to thread (C1). On the other hand, the weft threads (T2) intended to constitute the external layer, are also containing threads not presenting capacity to shrink.

In the specific example represented on figure 2, the density out of thread of chain (C2) and out of weft threads (T2) is divided by two compared to those (C1) and (Tl) of the other face.

Thanks to such a structure, the fact of using for the external layer of slightly shrinkable thermo thread, makes it possible to obtain a reaction to heat such as illustrated in figure 4.

Indeed, when the temperature reached by the external layer (2) is raised, for example in the case of the use to carry out thread of thread meta-aramide chain such as, for example: the isostalamides and the polyaramides, a temperature about 300°C, there is a shrinking of the external chain (C2) which involves a bringing together of the generators (3) of the area of connection. As the layer (1) is, as for it, stable dimensionally with heat, and is in addition protected partly by the external layer,

that involves the creation of a shrinkage on the internal side, and thus the formation of pockets in relief.

One must note that even if (C1) and/or (Tl) consisted of materials presenting a capacity to shrink, the fact that they are partially protected by the face (2) would create a differential of temperature seen by the two faces and thus a differential of shrinking creating the pockets in relief.

These spaces are progressively increased rise in temperature, which involves an increase thickness of the complex and a "trapping of air", and consequently, an increase in the insulating capacity.

Example:

One carries out a complex in conformity with the invention, standard illustrated by figure 2, and whose armor of weaving is illustrated by figure 6.

Chain (C1), intended to form the face directed towards the user, and weaves it (Tl) also intended to form this face, are carried out starting from a mixed fiber thread comprising fibers of polyamide imide (KERMEL) and fibers of viscose FR (containing an agent fireproofing), and this in a mixture 70/30, the weight of these threads being equal to Nm 70/2.

This face of fabric comprises 26 thread/cm and 24 picks/cm.

The chain (C2), which has this heat-shrinkable property and which constitutes the insulating layer is, as for it, composed of a fiber 100% thread containing polyamide fibers imide marketed under commercial name KERMEL TECR the weight of these thread being Nm60/2.

The density chains some (C2) is 13 thread/cm.

The weft (T2) is, as for it, identical to the internal weft and its density is 12 picks/cm.
With fallen from the trade, the surface mass of this complex fabric is approximately 230 g/m2.

The internal face (1), contexture, thus acts as lining, and which is that is directed towards the user.
The face (2) made up of shrinkable thermo thread in chain is that which acts as thermal barrier.

Obviously, the embodiment described and illustrated complex multi-layer material according to the invention should not be regarded as restrictive. The invention relates to any complex multi-layer material in sheets with an aim of producing a thermal barrier made up of a first and of a second layer by carrying out a structure double superimposed faces connected intermittently, so as to form pockets. The connection of the layers is carried out by intermittent binding of a thread selection.

One of the layers shrinks under the effect of heat. This effect of shrinking is obtained, if the illustrated example is considered, on totality or part of thread of connection constituting the pockets.

This effect of shrinking of the one of the layers can also result from the presence of a membrane fixed on the layer considered. For example, this membrane can be carried out in any material likely to present a shrinking under the effect of heat such as microporous polyurethane, absorbent polyurethane, absorbent polyester,

Possibly, the layer considered of complex material can be subjected to an operation of coating such as containing polyurethane, PVC, of silicone,..., to create the effect of shrinking sought under the action of heat.

After having subjected such a complex to tests of protection to radiant heat according to the standard EN 366 and to protection with convective heat according to the standard EN 367, it appears that the values of protection are high. Moreover, the difference between theoretical times of burn (t2 or HTI 24) and theoretical times of pain (Tl or HTI 12), are improved.

They are indeed greater than the general average observed for complexes of former art.

In addition, this result is obtained by having a material much more flexible, and which presents a less thermal load in normal use.

The advantages can be clearly seen from the description. A material is obtained that is much more flexible and comfortable, both physically and physiologically compared with prior art complexes.

One also improves perception of the danger by the fact that this typé of complex gradually adapts its level of insulation according to the thermal danger.

One can add that this complex does not present the problems of ageing of the conventional needled felts (migration of fibers, compressing,...), nor problems of abrasion undergone or created by the thermal barriers presenting a permanent relief.

Moreover, this new thermal barrier makes it possible to visualize the state of degradation of the complex. Indeed, the reaction being done only in extreme situation, it corresponds to a loss of effectiveness of fabric external and especially of the membrane generally associated in this type of clothing.

In the case of pockets in the shape of channels in the double fabric in conformity with the invention, those will preferably be laid out vertically in clothing in order to prevent that the light perpendicular shrinking does not go up the bottom of the jacket and the handles. This light tightening of the layer in question about the body of the carrier is not problematic, because it occurs in fact a redistribution from the protective air contained in clothing by supporting the places automatically where heat is punctually highest.

Obviously, the complex multi-layer material according to the invention can advantageously be combined with a structure also including an external fabric and an internal membrane breathing in general associated a substrate in accordance with the illustrated general provisions figure 1.

CLAIMS

1/Complex multi-layer material in sheet usable for the realization of protective clothing, in particular for firemen, and making it possible to produce a thermal barrier made up of a first and a second layer for the realization of such clothing, characterized in that it is carried out by weaving or knitting, so as to form a double face superimposed structure (1, 2), connected intermittently between them so as to form pockets, and in which:

one of the layers shrinks under the effect of heat;

the connection between the layers is carried out by intermittent binding of a thread selection to form the aforementioned pockets.

2/complex material according to claim 1, characterized in that the layer presenting a shrinking under the effect of heat is made up, entirely or partly, of thread presenting a shrinking under the aforementioned effect of heat.

3/complex material according to claim 1, characterized in that the pockets constitute of the channels, only the family of thread perpendicular to the known as channels, considered entirely or partly, presenting a shrinking under the effect of heat.

4/complex material according to claim 1, characterized in that the effect of shrinking of the layer considered results from the presence of a membrane fixed on the aforementioned layer, the aforementioned membrane being realized in a material ready to confer a shrinking under the effect of heat.

5/complex material according to claim 1, characterized in that the effect of shrinking of the layer considered results from the presence of a coating of the aforesaid the layer of a material ready to confer a shrinking under the effect of heat.

6/complex material according to claim 1, characterized in that the report/ratio of composition/[texture] between the two layers lies between for one and for ten.

7/complex material according to any of claims 1 to 6, characterized in that it is combined with an external fabric and a breathing membrane associated with a substrate.

FIG.1

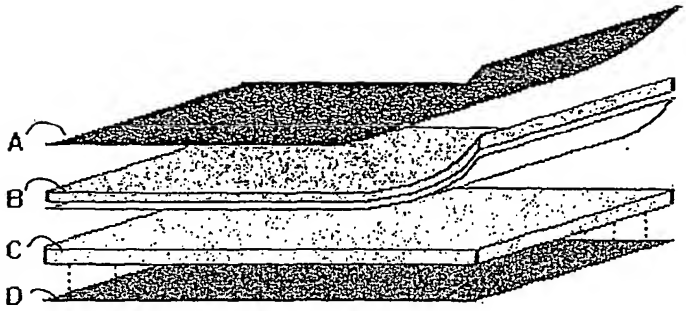


FIG. 2

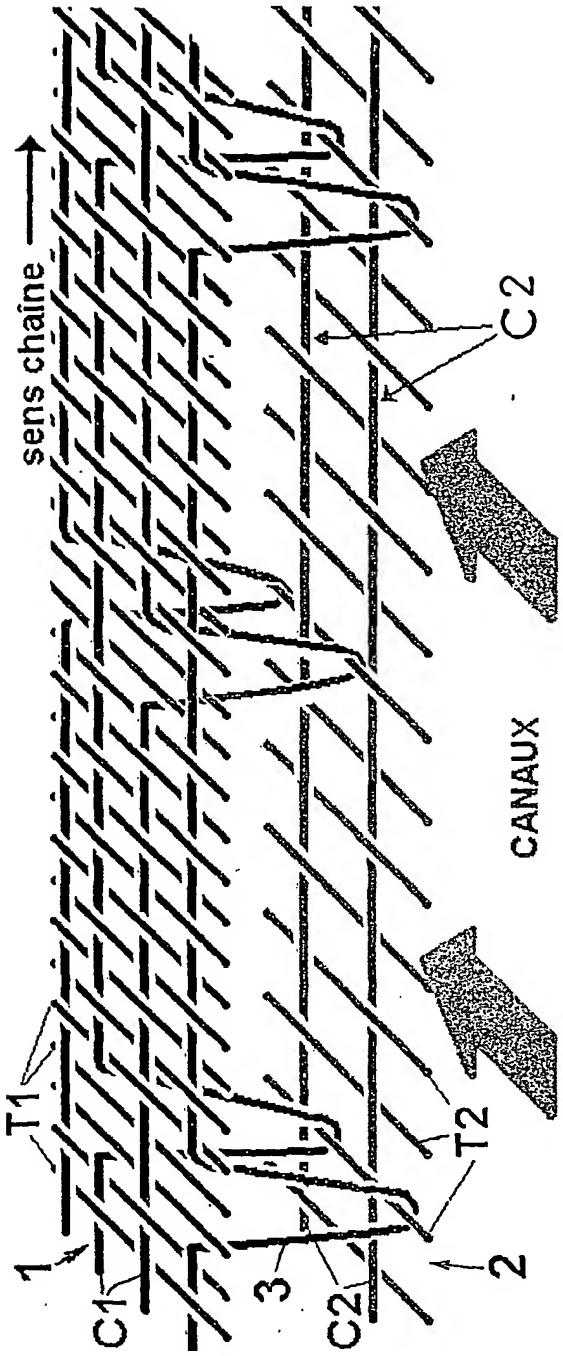
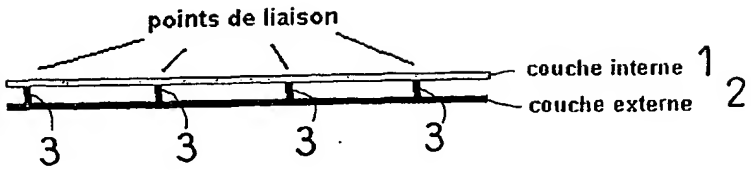


FIG.3

tissu double étoffe

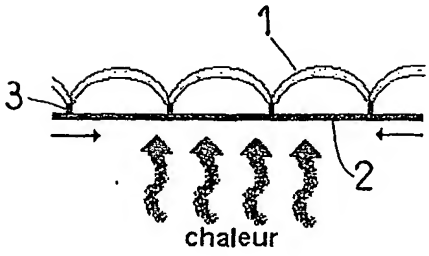


double fabric packs

points of connection

internal layer 1
- external layer 2

FIG.4

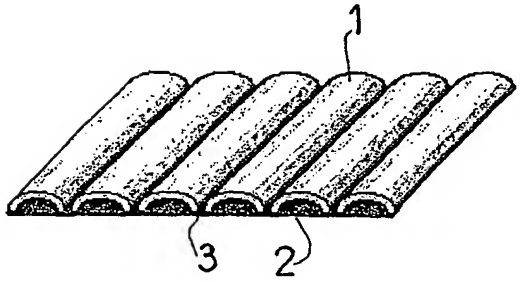


légère rétraction de la couche externe

light shrinking of the external layer

heat

FIG.5



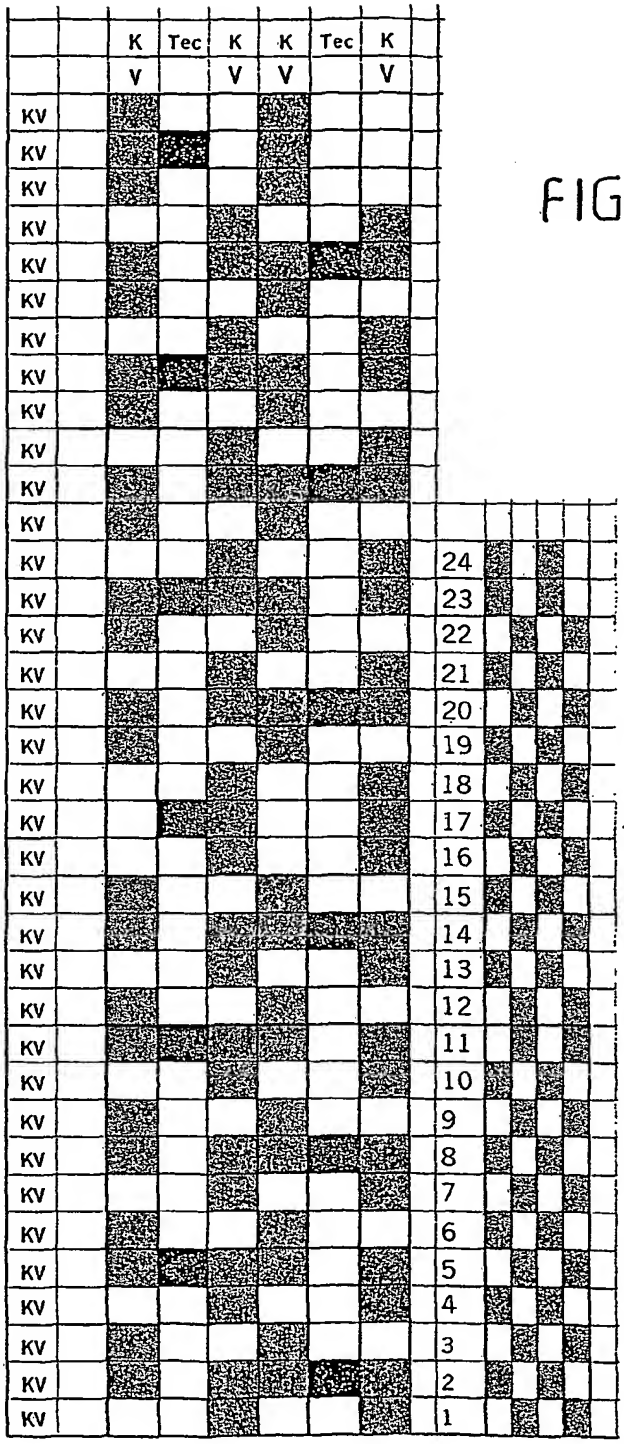

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FIG. 6

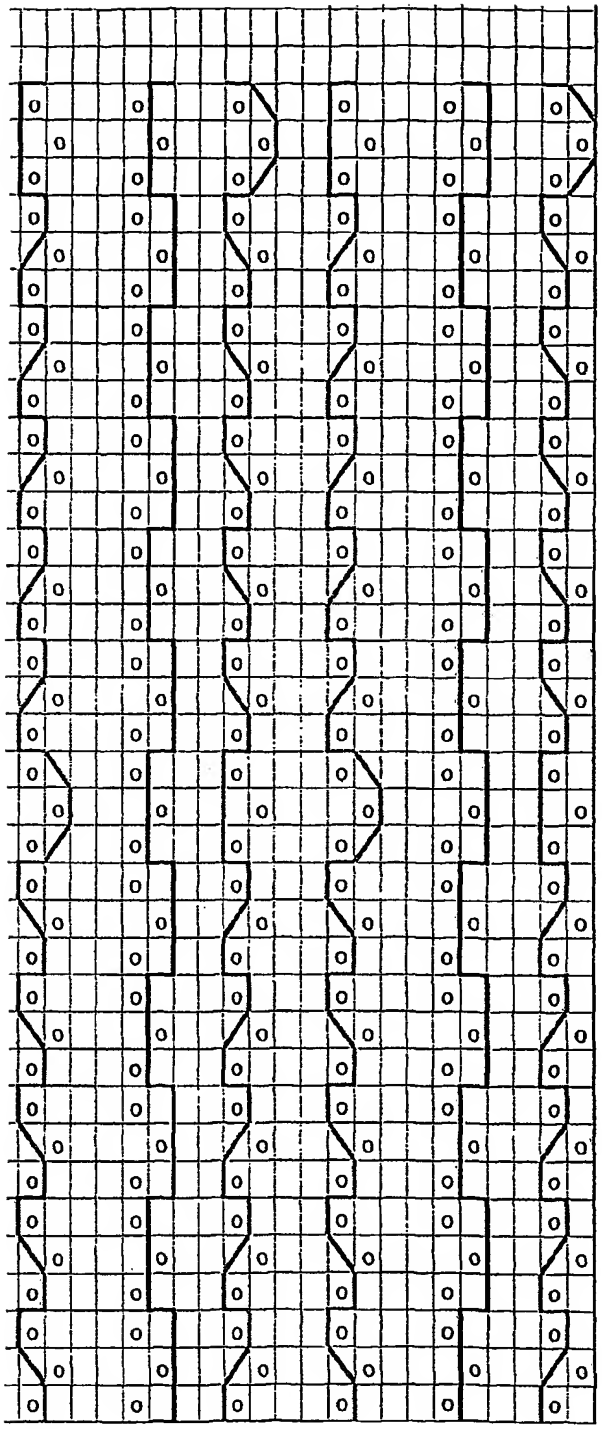

FIG.7.